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The effects of electronic meetings on group processes and outcomes: An assessment of the empirical research

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Abstract: In this paper we analyze the empirical research on the impacts of electronic meetings on group processes and outcomes. We define and differentiate two broad types of electronic meeting systems: Group Decision Support Systems (GDSS) and Group Communication Support Systems (GCSS). We then present a framework and method for analyzing the impacts of such information systems on groups that we develop from the literature of organization behavior and group psychology. We review the empirical research and findings concerned with the impacts of GDSS and GCSS on groups, and we compare and contrast these findings. Finally, we conclude by discussing the implications of our analysis on the focus of attention and the design of future research.

Our review of the empirical research suggests that GDSS and GCSS have similar impacts on some aspects of group processes and outcomes, but opposite impacts on other aspects. GDSS and GCSS both increase the depth of analysis of groups, increase participation, decrease domination by a few members, and increase decision quality. On the other hand, GDSS increase consensus reaching, decrease decision time, increase confidence in the decision by the group members, increase the satisfaction of group members with the process, and increase the satisfaction of the group members with the decision. GCSS decrease cooperation, increase the time to reach a decision, and decrease the confidence in decisions.

1. Introduction

Managers and professionals typically spend between 50% and 60% of their time in meetings which they often regard as unproductive and ineffective (Hymowits, 1988; Mintzberg, 1973; Mosvick and Nelson, 1987). With recent advances in computers, telecommunications and management science techniques, serious efforts have been made to use technology to enhance group performance in meetings (Jelassi and Beauclair, 1987). Thus the study of electronic meetings has become an important topic of interest in recent years. A multitude of vendors provide different products such as electronic boardrooms, teleconferencing facilities, group networks, information centers, decision conferences, and collaboration laboratories (Kraemer and King, 1988). Such facilities have been built by Management Information Systems (MIS) programs for the conduct of research aimed at understanding the effects that electronic meetings might have on group processes and outcomes. For example, facilities have been built at the University of Arizona, University of Minnesota, National University of Singapore, SUNY Albany, and Claremont Graduate School. Annual conferences are held on the subject or give major attention to it (Blanning and King, 1989; Galagher

* This paper is an expansion of earlier material presented in A. Pinsonneault and K.L. Kraemer, "The impact of technological support on groups: An assessment of the empirical research", *Decision Support Systems* 5 (1989) 197–216.

This expansion includes the addition of eleven studies to the survey data base making a total of twenty eight.

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et al., 1989), and several special issues of journals have highlighted recent research findings (Benbasat and Konsynski, 1988; Nunamaker, 1989).

Despite the recent research efforts, there are few clear indications of how electronic meetings affect groups. Empirical findings often appear contradictory and inconsistent. In an effort to bring order to recent research, this paper systematically reviews and assesses the empirical research on the impacts of information technology used to support electronic meetings, and group processes more generally. It establishes what we know and do not know about the impacts of electronic meetings on group processes and outcomes; how well we know; and where future research might usefully be oriented.

The remainder of the paper is organized as follows. In Section 2 we define and differentiate two broad types of electronic meeting systems: Group Decision Support Systems (GDSS) and Group Communication Support Systems (GCSS). In Section 3 we present a framework and method for analyzing the impacts of electronic meetings on group processes and outcomes. We develop this framework from systematic review of relevant literature in group psychology and organization behavior, and we use it to review the empirical research and findings in MIS. In Section 4 we analyze the studies concerned with the impacts of GDSS on groups. In Section 5 we analyze the research concerned with the impacts of GCSS on groups. In Section 6 we compare and contrast the empirical findings on the impact of GDSS and GCSS on groups. Finally, in Section 7, we conclude by discussing the implications of our analysis for future research.

2. A typology of electronic meeting systems

Most of the literature concerned with electronic meetings goes under the label of GDSS. Yet, there is more to electronic meetings than systems that support group decision processes. In fact, the purpose of many meetings is also to exchange information among members. Meetings are an arena for disseminating and gathering information

Table 1
A typology of electronic meeting systems

	GDSS	GCSS
Nature	• Decision aids • Support decision process	• Information aids • Support communication process
Purpose	• Reduce 'noise' in decision process	• Reduce communication barriers
Previous Taxonomies		
Zachary (1986)	• Choice model • Analysis and reasoning methods • Judgement refinement • Process model	• Information control • Representational capabilities
DeSanctis and Gallupe (1987)	• Level 2 support	• Level 1 and Level 3 supports
Benbasat and Nault (1988)	• Structured group techniques	• Group collaboration support
Dennis et al. (1988)	• Group decision support systems	• 'Computer-based systems for cooperative work'
Examples		
Hardware	• Decision conference • Conference room • Large screen	• Collaboration laboratory • Conference room • Electronic chalkboard
Software	• Decision analysis modeling	• Multi-user interface • WYSIWIS
Laboratories	• University of Arizona • Decision Techtronics, SUNY	• Colab Project, Xerox Parc • Project Nick • MCC

(Mintzberg, 1973; Schwartzman, 1986). Goffman (1961) defines 'meetings' as follows:

> "A meeting is a social form that organizes interaction in distinctive ways. Most specifically a meeting is a gathering of three or more people who agree to assemble for a purpose ostensibly related to the functioning of an organization or group (e.g., to exchange ideas or opinions, to make a decision, to formulate recommendations). A meeting is characterized by multi-party talk that is episodic in nature and participants develop or use specific conventions for regulating this talk. The meeting form frames the behavior that occurs within it as concerning the "business" of the group or organization." (p. 7)

Based on a previous review of existing aids for meetings (Kraemer and King, 1988), it is clear that several electronic meeting systems are in fact supporting the communication process of groups rather than the decision process per se. As shown in Table 1, there are basically two broad types of electronic meeting systems: Group Communication Support Systems (GCSS) and Group Decision Support Systems (GDSS). Differentiating these two types of electronic meeting systems might be an insightful avenue for making sense of apparent contradictory empirical findings. These systems support groups differently and therefore might be expected to have different impacts on group processes and outcomes.

GCSS are information aids. They are systems that primarily support the communication process between group members, even though they might do other things as well. The main purpose of GCSS is to reduce communication barriers in groups. These systems basically provide information control (storage and retrieval of data), representational capabilities (plotting and graph capabilities, large video displays) such as those discussed by Zachary (1986), and group 'collaboration support' facilities for idea generation, collection, and compilation such as those discussed by Benbasat and Nault (1988). GCSS also include 'Level 1' and 'Level 3' support of DeSanctis and Gallupe (1987) [1]. It also represents what Dennis, George, Jessup, Nunamaker and Vogel (1988) describe as 'computer-based systems for cooperative work'. Examples of GCSS are teleconferencing, electronic mail, electronic boardroom, and local group networks (Kraemer and King, 1988).

GDSS on the other hand are those systems that primarily attempt to structure the group decision process in some way. This corresponds to what Zachary (1986) characterizes as process models, choice models, analysis and reasoning methods, and judgement refinements. GDSS also corresponds to 'Group 7: structured group decision techniques' of Benbasat and Nault (1988), and to 'Level 2' support of DeSanctis and Gallupe (1987) [2]. GDSS also represents what Dennis et al. (1988) characterize as group decision support systems. Examples of this support are automated Delphi technique, Nominal group technique, information center, decision conference, handling aggregation of preferences ('Touchstone' systems), and the collaboration laboratory described by Kraemer and King (1988).

Of course, GDSS and GCSS are not mutually exclusive. Some electronic meeting systems support both the communication processes and the decision making processes of groups (see Bui and Jarke, 1984) (we classify research based on such hybrid systems as shown in Tables 2 and 3 below according to whether they *primarily* support the communication or decision making aspects of groups).

3. A framework and method for the analysis of impacts of electronic meeting systems

3.1. Framework for analysis

We developed our framework for analysis from systematic review of research in organization behavior and in group psychology (Pinsonneault and Kraemer, 1989). Based upon that review, we conceptualize the relationship between electronic meetings and group outcomes as involving three

[1] Level 1 of the typology of DeSanctis and Gallupe (1987) are technological supports that improve the decision process by facilitating information exchange among members. Example of Level 1 support are anonymous input of ideas and preferences, and electronic message exchange. Level 3 support is characterized by machine-induced group communication pattern.

[2] DeSanctis and Gallupe (1987) described Level 2 support of their typology as technological supports that provide decision modeling and group techniques aimed at reducing uncertainty and 'noise' that occur in the group's decision process. Examples of Level 2 support are modeling tools, risk analysis, and multiattribute utility methods.

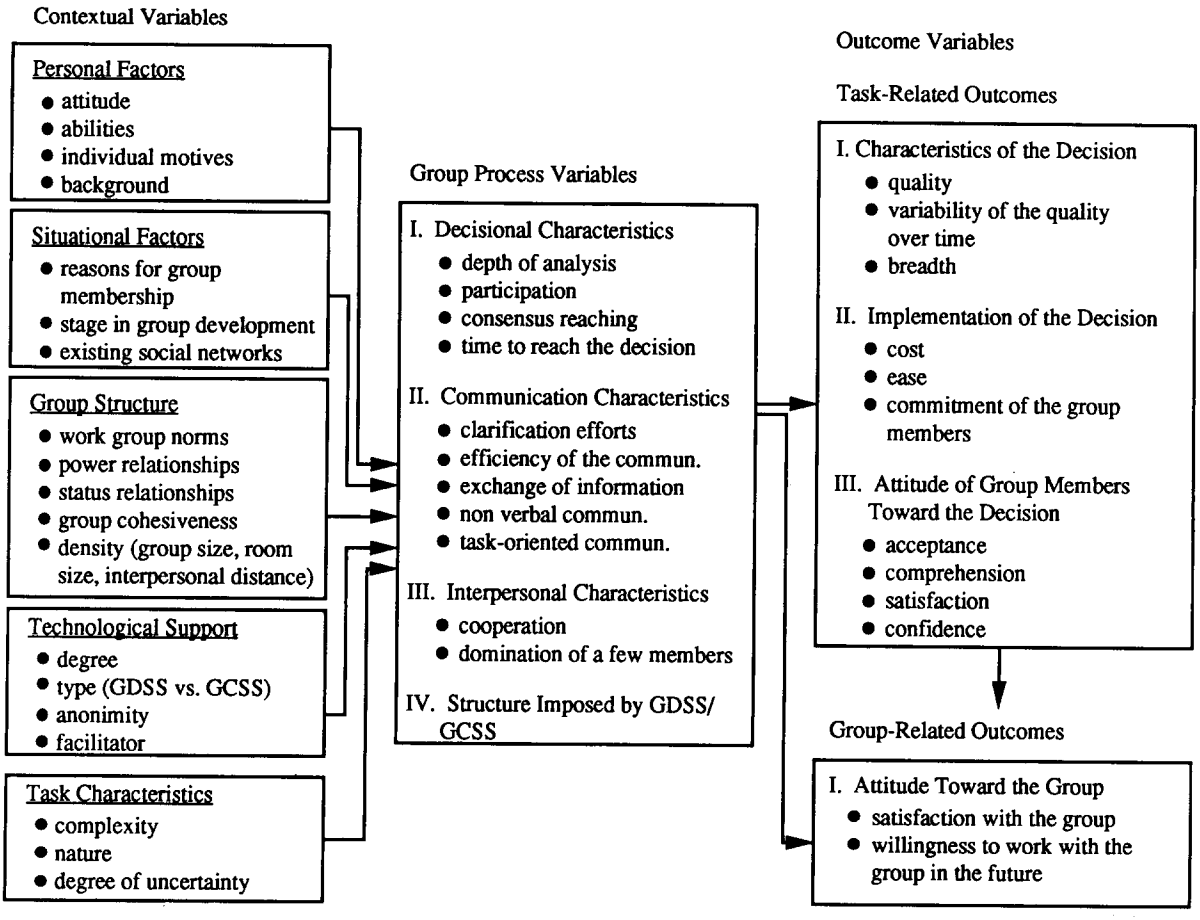

Figure 1. A framework for analyzing the impacts of GDSS and GCSS on group processes and outcomes (note that (1) the framework includes only the most important and relevant variables for electronic meetings studies, and (2) when there have been meetings for the sole purpose of communication of information, then the communication characteristics become the outcome variables of the research

broad sets of factors. As shown in Figure 1, these factors are concerned with: (1) the context, (2) the process, and (3) the outcomes of group interaction (task-related and group-related). Electronic meeting systems, which is the focus of this analysis, is a contextual factor along with personal factors, situational factors, structure of the group, and task characteristics.

The broad theoretical notion is that electronic meeting systems facilitate group process through enhancing group capabilities, removing barriers to group interaction, improving the group in its task, and building or reinforcing the social value of the group to its members through successful task performance. Thus, our framework and much of the MIS research, focuses on identifying the effects of electronic meeting systems on group processes while controlling for the effects of the other contextual variables. Group process in turn influences task-related outcomes which conjointly with group process, affect group-related outcomes. Each of the factors is discussed next and elaborate more fully in Appendix A.

3.1.1. Contextual variables

Contextual variables refer to factors in the immediate environment of the group rather than in the broader organizational environment. Five contextual variables are important in the behavioral research on groups: (1) *personal factors* (the attitudes, behaviors, and motives of individual group members); (2) *situational factors* (the extent of existing social networks and relationships among members of the group and the characteristics of the development of the group); (3) *group structure* (patterned relations among members of the group);

Table 2
Empirical research on GDSS

AUTHORS (YEAR)	CONTEXTUAL VARIABLES: Number of Groups: Experimental	Number of Groups: Control	Size of Group	Type of Decisions	Goal of Research	Research Strategy	INDEPENDENT VARIABLES: Personal Factors	Situational Factors: Group Membership	Stage in Group Development	Social Network	Task Characteristics: Complexity	Nature	Uncertainty	Group Structure: Group Norms	Power Relations	Status Relations	Cohesiveness	Group Size	Room Size	Physical Distance	Technological Support: GDSS: Generate	Choose	Negotiate	Anonymity	Facilitator	Structure Imposed on the Process	INTERVENING VARIABLES GROUP PROCESS: Decisional Characteristics: Depth of Analysis	Participation	Consensus	Time to Decide	Communication Characteristics: Clarification Efforts	Efficiency of Comm	Exchange of Info	Task Comm	Interpersonal Charact.: Cooperation	Domination by Few	DEPENDENT VARIABLES: TASK OUTCOMES: Characteristics of the Decision: Quality	Breadth	Satisfaction of Members	Confidence of Members	GROUP OUTCOMES: Attitude Toward Grp Proc: Satisfaction
Steeb & Johnson (81)	5	5	3	complex political crisis	impact of gdss on decision quality	LAB EXP	?	?	1		H	C	H		?			C	?	?	X	X	X	?	C	NC	+		+	+					+					+
Gray (83)	4	0	?	4 different decisions		LAB EXP impression	NC	NC	2-3	H	M	NC	L		NC	NC	?	NC	?		X	X	X	?	?	?	+							+						
George et al. (87)			6	sales territories *assignment*	impact of leadership *anonymity* and gdss	LAB EXP	Cr	Cr	?	Cr	L	C	L	?	X X ?						X ? X	X ? X	X ? X	H ? ?	? ? ?	? ? ?		+		-			+			-	+				
Nunamaker et al. (87)	7	0	6-22	different strategic planning		Field Study	NC	NC	?	?	H	NC	H	?	NC	C	?	NC	C	C	X			H	?	NC		+									+			+
Nunamaker (87)			5			Case Study																																	+	+
George et al. (88)	30		6	sales territory *assignment*	FTF vs. gdss	LAB EXP	?	?	1-2	?	M	C	L	?	H L	C NC		C C	C C	C C	X X	X X	X X	H L						+	-				+				+	+
Nunamaker, et al. (89)	?	0	8-10	DP Planning	impact of GDSS	Field Study	?	?	?	?	M	C	M	?	?	?		?	C	C	X	X	X	H	?	NC				-									+
Jessup et al. (88)	5		4	university parking problem	impact of anonymity & proximity	LAB EXP	Cr	Cr	1	L	M	C	L			?	?	C	C		X			H L	C C	?					+									+
	5																		C	H L	X			C	C	?					+									+
	5																			H L	X			H H L	C	?					++			++						++
	5																			H L	X			H L	C C	?					-			++						++
Nunamaker et al. (88)	40	0	3-22	varied		Field Study	NC	NC	?	?	?	NC	?		NC	C	?	NC	?	C	X	X	X	H	NC	NC	+	+		+	+				-					+
Vogel & Nunamaker (88)	multiple		varied	varied		Multiple	NC	NC	?	?	?	?	?		NC	?	?	C	?	C	X	X	X	?	NC	NC	+	+	+	-									+
Bui & Sivasankran (87)			3								High Low										X	X	X		NC NC				o +										
Bui & Al (87)	6	6	3	Selecting a regional director		LAB EXP	C	?	1	C	M	C	M	?	?		?	C	?	?	X	X	X	?	?	NC				-										

Table 3
Empirical research on GCSS

AUTHORS (YEAR)	CONTEXTUAL VARIABLES: Number of Groups: Experimental	Number of Groups: Control	Size of Group	Type of Decisions	Goal of Research	Research Strategy	INDEPENDENT VARIABLES: Situational Factors: Personal Factors	Group Membership	Stage in Group Development	Social Network	Task Characteristics: Complexity	Nature	Uncertainty	Group Structure: Group Norms	Power Relations	Status Relations	Cohesiveness	Group Size	Room Size	Physical Distance	Technological Support: GCSS: Generate	Choose	Negotiate	Anonymity	Facilitator	Structure Imposed on the Process	INTERVENING VARIABLES: GROUP PROCESS: Decisional Characteristics: Depth of Analysis	Participation	Consensus	Time to Decide	Communication Characteristics: Clarification Efforts	Efficiency of Comm	Exchange of Info	Task Comm	Inter-personal Charact.: Cooperation	Domination by Few	DEPENDENT VARIABLES: TASK OUTCOMES: Charact. of the Decision: Quality	Breadth	GROUP OUTCOMES: Attitude Toward the Decision: Satisfaction of Members	Confidence of Members	Attitude Toward Grp Proc.: Satisfaction
Gallupe et al. (88)	6 6 GCSS	6 6 man	3	marketing case	impact of GDSS & task difficulty on quality	LAB EXP	Cr Cr	Cr Cr	2-3 2-3	M M	high low	C C	M M		? ?	? ?		C C	C C	C C	X X	C C	C C	? ?	NC NC	C C	+ +	o o	- -	+ +					- -		++ +			-	-
Zigurs et al. (87)	30 GCSS	30 man	3-4	develop admittance criteria & choose	impact of GCSS on influence behavior	LAB EXP	Cr	Cr	3-4	H	M	C	M	Cr	Cr	Cr	Cr	C	C	C	X	X	X	?	?	C		+									o		-		
Watson et al. (88)	total	82	3-4	resource allocation	impact of GCSS on behavior	LAB EXP	Cr	Cr	3-4	H	M	C	M	Cr	Cr	Cr	Cr	C	C	C	X	X	X	?	?	C			o												
Poole et al. (88)	total GCSS	40 man	3-4	resource allocation	impact of GCSS on behavior	LAB EXP	Cr	Cr	3-4	H	M	C	M	Cr	Cr	Cr	Cr	C	C	C	X	X	X	?	?	C		o	o		o										
Zigurs et al. (89)	8		4-5	strategic planning	impact of GCSS use	LAB EXP	?	?	2-3	?	M	C	M	?	?	?	?	C	C	C	X	X	X	?	C	NC											o				
LeBlanc & Kozar (87)	1	0	?	mgmt of vessel traffic	impact of GCSS	Longitu-dinal case study			4		M		H		?	?	?	?	C	C	X	X	X			NC											+				
Zigurs et al. (88)	14	18	3-4	admission of students	impact of GCSS on process	LAB EXP	NC	NC	3-4	L	M	C	L	?	?	?	?	?	C	C	X	X	X	?	C	C							-		-		o				
Jarvenpaa et al. (88)	3	0	7	unstr. so finite designing task	impact of GCSS	Field Study	Cr	Cr	?	?	M	C	M	?	C	C	?	C	NC	NC	X	X	X	?	C	C		o						-	-		+				o
Dickson et al. (89)	5 5 5		3-5 3-5 3-5	resources allocation	impact of 3 types of use	Exploratory LAB EXP	NC	NC	2-3	M	M	C	L	NC	NC	NC	NC	C	?	?	Facilitator Chauffer user driven			? ? ?	X	C C C			++ +++ +										o o			
Easton et al. (89)	6	12	4	analysis of policy stat	impact of GCSS	LAB EXP	Cr	Cr	1-2	L	L	C	L	Cr	Cr	Cr	Cr	C	?	?	X	X	X	?	C	C				+				-		+			o			o
Ellis et al. (89)	2	1	7	Unstr. software design	impact of GCSS	Field Exp.	Cr	Cr	?	?	M	C	M	Cr	Cr	Cr	Cr	C	C	C	Electr. blackboard Electronic work stat. manual																	++ +					

Table 3 (*continued*)

Siegel et al. (86) #1	18	0	3	career choice	GCSS anonymous & non-anonymous vs. ftf	Univ. Settings	Cr	Cr	1	L	?	?	?		NC			C	NC	NC	X	X	X	H	C	?	+	+		+		-	-	o	-	-					
							Cr	Cr	1	L	?	?	?		NC			C	NC	NC	X	X	X	L	C	?	+	+		+		-	-	o	-	-					
#2	12	0	3	career choice	Simul. vs. sequential	Univ. Settings	Cr	Cr	1	L	?	?	?		NC			C	C	C	SI	SI	SI	?	C	?				+					-		o				
							Cr	Cr	1	L	?	?	?		NC			C	C	C	SE	SE	SE	?	C	?				+					-		o				
#3	18	0	3	career choice	Simul. & E-Mail vs. ftf	Univ. Settings	Cr		1		?	?	?		?					C	SI	SI	SI	?		?		+		+				o	–						
							Cr		1		?	?	?		?					C	SE	SE	SE	?		?															
Smith & Vanecek (89)	7	10	5	murder mystery	impact of GCSS	Field Exper.	NC	NC	?	?	M	C	L	NC	NC	NC	NC	C	NC	X	X	X	X	?		?	-	o					-								
Hiltz et al. (86)	4	4	5	artic. survival	impact of GCSS	LAB EXP	Cr	Cr	?	?	M	Nc	H	?	NC			C	?	?	X	X	X					+	-		-	-				-	o				
	4	4	5	forest ranger	impact of GCSS	LAB EXP	Cr	Cr	?	?	M	Nc	M	?	NC			C	?	?	X	X	X					+	-		-	-				-	o				
Turoff & Hiltz (82) #1	8	8	5	artic. survival	impact of GCSS on design quality	LAB EXP	Cr	Cr	1st	L	M	C	H	?	?	?		C	?	NC	X	X	X	?	?	C	+	+	-	+			-	+		-	o			+	
#2	6	6	5	artic. survival	impact of GCSS on quality decision	Field Exp	?	?	1st	L	M	C	H		x	x		C	?	NC	X	X	X	?	?	C															
							?	?	1st	L	M	C	H		x	x		C	?	NC	X	X	X	?	?	C			o								+				
	6	6	5			Field Exp	?	?	1st	L	M	C	H		C	C		C	?	NC	X	X	X	?	?	C			+								+				
							?	?	1st	L	M	C	H		C	C		C	?	NC	X	X	X	?	?	C			+								+				
#3 Hiltz et al. (88)	6		5	3 choice dilemma prob.	impact of anonymity	Field Exp	Cr	Cr	3-4	H	M	C	L	?	?	?		C	NC	NC				L												+					
	6		5				Cr	Cr	3-4	H	M	C	L	?	?	?		C	NC	NC	X	X	X	H				+	o						o						
	6		5				Cr	Cr	3-4	H	M	C	L	?	?	?		C	NC	NC	X	X	X	L					o						o						

H: High
M: Medium
L: Low
C: Controlled
Cr: Controlled (Random Assignment)
NC: *Not Controlled and Possibly Important*
Blank: Not Relevant

X: Variable Manipulated
?: Insufficient Data, May Be Important

+: Variable Increased
-: Variable Decreased
o: Variable Static

IDP: Individual Decision Process
GDP: Group Decision Process

GDSS: Group Decision Support System
GCSS: Group Communication Support System

Stage in Group Development
1=Testing and dependent
2=Intragroup conflict
3=Development of group cohesion
4=Functional role related efforts

(4) *technological support* (what activities the electronic meeting systems support and the extent of support they provide); and (5) *task characteristics* (the attributes of the group's substantive work).

3.1.2. Group process variables

Group process variables refer to characteristics of the group's interaction, and generally attempt to capture the dynamics of that interaction. We segment group process into three categories: (1) *decisional characteristics* (how decisions are made); (2) *communication characteristics* (the process through which information is exchanged in the group and the focus of this exchange); (3) *interpersonal characteristics* (the 'fit' between the members of the group); and (4) *the structure of these group processes* (the degree of standardization and formalization of the group processes).

3.1.3. Outcomes variables

The outcomes variables refer to the characteristics of the performance of the group. We segment them into two categories: (1) task-related outcomes (the characteristics of the decision taken by the group, if any), and (2) group-related outcomes (how the group members perceive the group process).

3.2. Method of analysis

To examine what the research says about these foregoing sets of factors, we group the studies by whether they focus on electronic meeting systems primarily aimed at reducing noise in collective decision processes (GDSS, see Table 2) or at reducing communication barriers between members of a group (GCSS, see Table 3). We characterize further the electronic meeting systems by whether they support the generation of alternatives, the choice of alternatives and/or the negotiation over alternative generation or choice, by the degree of anonymity they permit, and by whether a meeting facilitator is part of the support provided.

For each study, we then assess, based on information available in published articles and/or research reports, how each study addresses the different variables of our framework. We determine what are the dependent and independent variables studied, and also what are the contextual variables controlled and not controlled. We do not include all the independent, dependent, and contextual variables addressed in MIS, but only those focused on by several studies and those found to be important in the organization behavior or group psychology literature.

Even with these limitations on the scope, our assessment provides a powerful and systematic approach to establish the knowledge cumulated to date. What is known, what is not known, where research efforts should be oriented, and what major weakness and threats to validity should be addressed stem clearly from such an analysis. We analyze the major findings (the dependent variables on which at least a couple of studies focused) at three levels. First, we determine whether the findings for a particular variable are consistent across the different studies. For example, have all studies that focus on the impact of GDSS on decision quality found similar effects (positive (+), negative (−), or no relationship (0)), or are there inconsistencies between findings? Second, we identify the contextual variables that are controlled and those that are not controlled by each study that focus on a given variable and we determine whether or not any contextual variable can offer an alternative explanation to the finding. For example, is there a contextual variable that is left uncontrolled by all studies focusing on the impact of GDSS on decision quality that can cause the relationship between GDSS and decision quality? Third, we determine whether or not the findings related to different dependent variables are consistent with one another, within and across factors (group process, task-related outcomes, group-related outcomes). For example, is the overall finding of the impact of GDSS on decision quality consistent with the finding of the impact of GDSS on depth of analysis or on confidence in the decision by the group members?

In a literature review such as this one, the validity of a finding depends less on the quality of any one particular study, than on the diversity of contextual variables controlled and not controlled in the set of studies. Consequently, the more heterogeneous the distribution of uncontrolled contextual variables in a set of studies, the more valid the finding common to the set of studies. Our approach to review the literature then is not as much to discuss each study in detail, but to focus on findings across a set of studies and to discuss the similar and differential of GDSS and GCSS on groups.

4. Impacts of GDSS on groups

Figure 2 summarizes the findings related to major variables studied in GDSS research.

4.1. Group processes

GDSS affect group processes in four major ways. First, *GDSS increase the overall quantity of effort* put forth in the decision process by the group members. GDSS incite more members to participate or the same number of members to invest more effort. The vast majority of the studies found that GDSS groups had more participation, that this participation was more egalitarian, and that those groups were less likely to be dominated by one or a few members (George et al., 1987; Nunamaker et al., 1987; Nunamaker et al., 1988; Vogel and Nunamaker, 1988).

Second, *GDSS focus the efforts of group members toward the task*, or problem to be solved by the group. There is a high consistency across studies. Research clearly show the GDSS increase task-oriented communication and the clarification efforts of group members (Gray, 1983; Jessup et al., 1988; Nunamaker et al., 1988). This increased focus toward the task increases the depth of analysis. Here again the majority of studies found that GDSS groups analyzed a greater number of alternatives and/or analyzed each alternative in greater depth (Gray, 1983; Nunamaker et al., 1988; Steeb and Johnson, 1981; Vogel and Nunamaker, 1988). This result is consistent with the findings of greater clarification efforts.

Third, *GDSS increase consensus reaching*. All but one study found that GDSS groups arrived at a consensus over a decision more often than non-supported groups (George et al., 1988; Steeb and Johnson, 1981; Vogel and Nunamaker, 1988). This appears inconsistent with the previous finding of increased participation. One would expect consensus to decrease as more people voice their opinion and try to have their agenda supported by others. Actually this result is not inconsistent. GDSS focus the efforts of the group members on the task to be solved (second finding), and, therefore, greater participation combined with a heightened focus of attention leads to higher consensus reaching.

Finally, GDSS decrease the *decision time*. Six out of eight studies found that GDSS groups took less time to arrive at a decision (Bui et al., 1987; George et al., 1988; Nunamaker, 1987; Nunamaker et al., 1988, 1989; Vogel and Nunamaker, 1988). The field studies found that the use of GDSS resulted in significant reductions of 'man hours' spent in meetings. The shorter time to make a decision experienced by GDSS groups is an interesting result. It appears it might reflect the fact that although GDSS increase participation

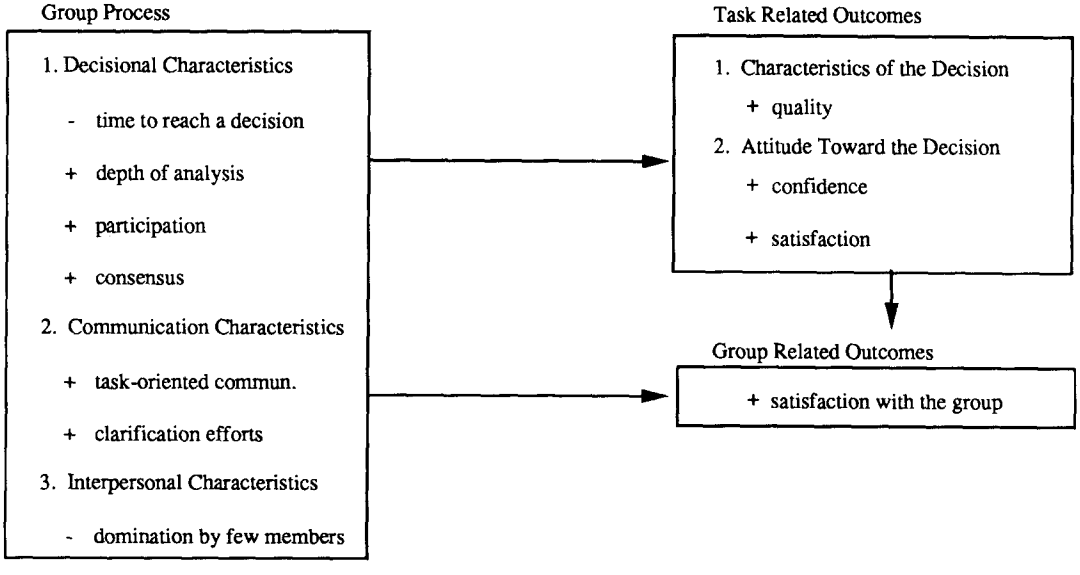

Figure 2. The impact of GDSS on groups (+ means positive relationship between GDSS and the factor, and − means negative relationship between GDSS and the factor)

thereby increasing the needed decision time, GDSS also focus efforts on the task thereby reducing the needed decision time overall.

4.2. Group outcomes

GDSS were also found to affect group outcomes in three major ways. First, GDSS increase *decision quality*. Most studies found that GDSS groups outperformed non-supported groups (Bui et al., 1987; George et al., 1987; Steeb and Johnson, 1981). This increased quality is consistent and might in fact be caused by a greater focus of efforts on the task.

Second, consistent with the previously enumerated findings, GDSS were also found to increase the *confidence of group members in decisions*, and the *satisfaction of group members with the decision* (Nunamaker et al., 1987; Steeb and Johnson, 1981; Vogel and Nunamaker, 1988). This is likely to result from GDSS increasing participation, consensus, and decision quality.

Third, GDSS increase the *satisfaction of members in the group process*. Eight out of nine studies found that members of GDSS groups were more satisfied with the group process than were members of non-supported groups (George et al., 1988; Jessup et al., 1988; Nunamaker, 1987; Nunamaker et al., 1987, 1988, 1989; Steeb and Johnson, 1981; Vogel and Nunamaker, 1988). It seems that effects of GDSS on group process and other outcomes in turn lead to greater satisfaction of group members with the group processes. The increased satisfaction with the group process is consistent with the findings of higher consensus, better decision quality, higher confidence in the decision, higher satisfaction with the decision, increased participation, and lower decision time.

4.3. Assessment of the findings

Overall, GDSS research provides relatively consistent findings both within groups of variables (group process, task-related outcomes and group-related outcomes) and across groups of variables. The research shows that GDSS: (1) increase the depth of analysis; (2) increase the task-oriented communication and clarification efforts; (3) increase the degree of participation and decrease the domination by a few members; (4) increase consensus among members of the group; and (5) decrease decision time. These impacts seem to increase the quality of decisions which in turn, increases the confidence and satisfaction of group members toward the decision. Furthermore, the changes in group process and in the task-related outcomes increase the satisfaction of group members with the group process.

Also, most of these findings are robust. The findings of increased participation and increased task-oriented communication and clarification efforts were obtained with groups ranging from three to twenty-two members. These positive impacts were also obtained with both students in laboratory setting and managers in 'real' settings performing 'real' managerial tasks.

The findings of increased decision quality and increased depth of analysis are also robust. They were obtained with groups solving tasks of different complexity and uncertainty. The positive findings related to depth of analysis also occurred with decisions ranging from complex political crisis to strategic planning activities. Also, the validity of this finding is reinforced by its generalized occurrence. The relationship was observed in studies with students and with managers performing 'real' managerial tasks.

However, five points need to be made that are common to most GDSS studies and weaken the validity of some findings. Firstly, *there is a lack of control for the effect of greater structure on group processes resulting from the technological support* in most GDSS studies. This is particularly important because greater structure of the processes might cause changes in the group process variables and in the outcome variables, rather than the GDSS. For example, Steeb and Johnson (1981) compared groups with no aid other than paper and pencil, with groups using GDSS support that provided computer-aided decision tree analysis. The positive relationship between GDSS and several group variables might not be an effect of the technological support, but rather the greater structure imposed on the group processes by the GDSS. Moreover, different types of GDSS might impose a very different form and degree of structure. This is particularly important for the findings of increased decision quality and increased task-oriented communication and clarification efforts where the structure of group process imposed by the GDSS was not controlled. Consequently, these results might be more indicative of greater struc-

ture of the group process rather than electronic meeting systems themselves.

Secondly, *the selection process of many studies favor 'computer prone participants'*. These participants expect and want to use computer aids, but they also might be favorably biased in their estimate of the capabilities and of the impacts of computer aids on the group processes. This particularly affects the positive findings of participation, confidence, and of satisfaction in the decision. The managers who go to a university setting to use its computerized systems are likely to be very motivated; those who are not motivated, do not go; therefore, it is normal that participation in the group increases. This problem is significant because in most of studies with managers there were no control groups. In studies with students the selection of participants was often done on a voluntary basis. Therefore, here again it might well be that the study attracted a very specific group of participants (those who enjoy using computer aids). This might positively bias the participation level of the subjects and their confidence in the decision, as well as their satisfaction with the decision when they are assigned to computer supported groups, and negatively affect those variables when they are in non-supported groups. Therefore, it is plausible that the control group and the experimental group of these studies were not really comparable. In other words, participants might be predisposed toward using a computerized system by the mere fact of participating voluntarily in the experiment.

Thirdly, *many GDSS studies focus on the very early stages of group development* where group members try to establish and understand the norms of the groups, try to define and defend their position, and try to obtain a basis of influence over the decision process. GDSS might have significant effects on groups at the early stages of development because it permits the members to focus more rapidly and intensely on the task itself. In a sense GDSS might decrease the time needed to arrive at the 'functional' stage of group process and therefore permit technologically supported groups to outperform non-supported groups. However, most business meetings are composed of people two know each other very well and are used to working together in groups (Bui et al., 1987). Therefore most groups are at the later stages of group development, for which the current findings cannot be extended. The increase in decision quality might be significant for groups at early stages of their development but not for group already at the 'functional' stage. Also, the benefits of GDSS increasing task-oriented communication and clarification efforts might be minimal for more advanced groups, where members already focus on the task. Research is clearly needed on the relationship between technological support and the stages of group development.

Fourthly, many *findings are impressionistic* in nature. This is particularly true for the findings related to the participation, decision time, confidence in the decision, and satisfaction with the decision. These findings were obtained in studies with no control groups and research designs that did not carefully control most contextual variables.

Finally, *several GDSS studies do not monitor the potential effects of a meeting facilitator* (or do not provide enough information to determine if they did). A facilitator might affect group processes and outcomes in two ways: (1) intentionally, by playing an active role in planning, conducting, and facilitating the processes, or (2) unintentionally, by (a) mere presence, which changes the atmosphere or the relationships between group members, or (b) being a good versus bad facilitator (i.e., being able or not being able to provide the information required by the group members). The unintentional effect may be particularly important with student participants. Students may perceive the meeting facilitator as a professor or professor's assistant evaluating them, which might influence their behavior.

5. Impacts of GCSS on groups

We now turn to examine the research on Group Communication Support Systems in relation to groups. As discussed earlier, GCSS focus primarily on information aids rather than decision models per se. They mainly support the communication process between group members.

Figure 3 summarizes findings related to major variables studied in GCSS research.

5.1. Group processes

Research shows that GCSS affect group processes in five major ways. First, GCSS increase

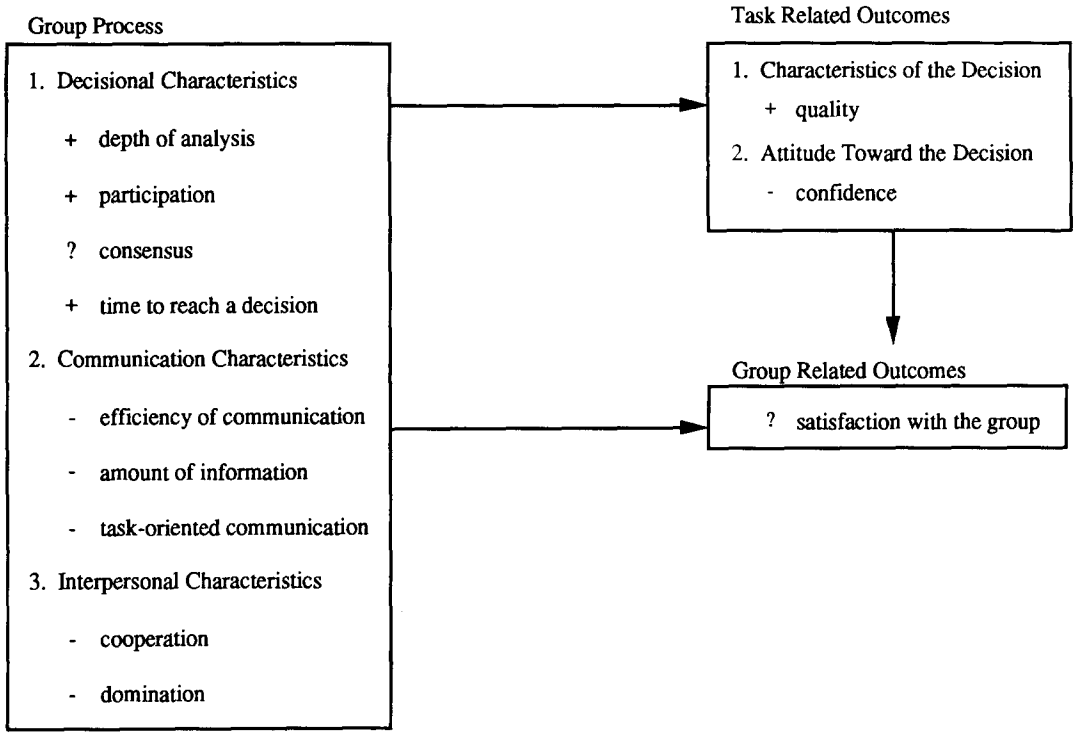

Figure 3. The impact of GCSS on groups (+ means positive relationship between GCSS and the factor, − means negative relationship between GCSS and the factor, and ? means inconsistent relationship between GCSS and the factor)

the total effort put forth by the group members. GCSS incite more members to participate or the same number of members to invest more effort. Four out of six studies found that GCSS groups have more participation, have more egalitarian participation, and are less inclined towards domination by one or a few members (Hiltz et al., 1988; Siegel et al., 1986; Turoff and Hiltz, 1982; Zigurs et al., 1987). This result is consistent with the findings that GCSS decrease consensus and increase the time needed to reach a decision (discussed below).

Second, GCSS increase the depth of analysis of group processes. The vast majority of studies found that the GCSS groups analyze more alternatives or analyze the same number of alternatives in greater depth (Gallupe et al., 1988; Siegel et al., 1986; Turoff and Hiltz, 1982). This finding is consistent with the finding of higher decision quality and increased decision time.

Third, GCSS decrease overall cooperation of groups (results on consensus are mixed). Most studies found that the GCSS groups members are less cooperative (Gallupe et al., 1988; Siegel et al., 1986; Turoff and Hiltz, 1982; Hiltz et al., 1986). It appears that the increased participation is not all channeled toward the task, but also toward other behaviors (e.g., personal, political). Quite surprisingly, the vast majority of the studies that focus on the impact of GCSS on the communication process of groups found a negative effect. GCSS were found to decrease the efficiency of communication (Hiltz et al., 1986; Siegel et al., 1986); decrease the amount of information exchanged (Jarvenpaa et al., 1988; Siegel et al., 1986; Smith and Vanecek, 1989; Turoff and Hiltz, 1982); and decrease the task-oriented communication (Jarvenpaa et al., 1988; Zigurs et al., 1988). This group of findings can be explained by the increased participation. When individuals participate more actively in the group process, they have a better defined and more clear cut idea about their own preferences and their relationship to the potential outcomes, and they also voice more their opinion.

Finally, consistent with the previously discussed impacts, research shows that GCSS increase decision time. It was found in all studies that focused on this variable that GCSS supported groups took longer to reach a decision (Easton et al., 1989; Gallupe et al., 1988; Siegel et al., 1986;

Turoff and Hiltz, 1982). This is consistent with the other findings of increased depth of analysis and decreased consensus and cooperation.

5.2. Group outcomes

Research show that GCSS also affect group outcomes in two major ways. First, GCSS increase the quality of decisions. A majority of studies found the GCSS groups outperform nonsupported groups (Bui and Sivasankaran, 1987; Easton et al., 1989; Ellis et al., 1989; Gallupe et al., 1988; Jarvenpaa et al., 1988; Leblanc and Kozar, 1987; Turoff and Hiltz, 1982). It is significant to note that even though this finding is inconsistent with some findings about group processes discussed above (like decreased cooperation), it is consistent with most other findings (increased depth of analysis, increased participation, increased time to reach a decision).

Second, quite surprisingly, the findings clearly converge toward indicating that GCSS decrease the confidence of group members in the decisions (Gallupe et al., 1988; Watson et al., 1988; Zigurs et al., 1987). While decreased confidence is consistent with decreased cooperation, it is inconsistent with increased participation, increased depth of analysis, and increased decision quality.

The findings regarding group outcomes discussed above might be related to decreased cooperation among group members. GCSS may be efficient in terms of increasing performance of the groups (formal aspect) but not in terms of the interpersonal characteristics of groups (informal aspect). This might explain the fact the GCSS group members are less confident in the decision than they would be otherwise.

If these findings and the explanation advanced prove to be right, it raises questions about the long term future of GCSS. One of the most often used rationale for electronic meeting systems is that they are said to democratize and to facilitate decision making process in meetings, which is expected to result in better performance and outcomes. However, research indicates that GCSS seem to reinforce existing structures, resulting in both positive and negative effects.

5.3. Assessment of the findings

Overall, the research on GCSS is consistent. The findings show that GCSS: (1) increase the depth of analysis; (2) increase participation and decrease domination by a few members; (3) decrease cooperation; and (4) increase the time groups take to reach a decision. The greater depth of analysis, participation, and the increased decision time seem to increase the quality of decisions. The decrease in cooperation seems to decrease confidence in the decision.

Also, several of these findings are robust. The findings of increased decision quality and increased depth of analysis were obtained in diverse types of decisions (arctic survival problem and career choice problem), and therefore, they do not seem to be dependent on the type of problem. Also, although most studies focused on problems of medium complexity, Gallupe et al. (1988) found no difference between high and low complexity problems; therefore, this should not affect the generality of the findings. Also, alternative explanations were well controlled in the set of studies focusing on depth of analysis. Several studies controlled the degree of structure imposed by the GCSS, and the potential impacts of a facilitator was controlled in one study (Siegel et al., 1986). However, results were identical in all these studies; apparently the facilitator did not have a critical impact on the relationship between GCSS and the depth of analysis. The finding of increased decision quality was also obtained in groups at different stages of their development.

However, four qualifying points need to be made. First, as in the GDSS studies, *the selection of participants might bias the results obtained*, particularly concerning increased participation. Second, the majority of the GCSS studies used *students* which limits the generality of the findings. Third, the majority of the studies were conducted with *small groups* (typically three or four members). There are good reasons to expect that the findings would be different in larger groups.

Fourth, most studies do not account for the effect of the group's stage of development. This deficiency, although it might not be the only factor, seems to explain numerous inconsistencies in the findings. Most studies that found a positive relationship between GCSS and participation focused on groups that were in early stages of development, and the studies that found no change, focused on groups that were in advanced stages of development. This pattern also fits the findings on the dominance in groups. The studies

that found a negative relationship between GCSS and domination focused on groups in early stages of development, while the studies that found no relationship focused on groups in later stages of development. This observation might reflect the fact that the change in the participation pattern and in the structure of dominance is possible only at the beginning of group formation, but not later, when the pattern of participation and the structure of dominance are already established. GCSS decrease the dominance of particular dominant groups or individuals in early stages of group development, but seem unable to modify the structure of dominance and the pattern of participation already existing in groups at later stages of their development.

The positive relationship between GCSS and the depth of analysis was also obtained with groups in the early stages of group development. GCSS might permit groups at this stage to increase their focus on the task, or, in other words, to arrive at a functional stage faster than those not supported. Moreover, the impact might be different in groups at more advanced stages of development. However, the finding of a negative impact of GCSS on cooperation was obtained in groups at early stages of development. Those studies that found no relationship focused at latter stages of group development. This suggests that GCSS reinforce the existing structure of the group. When applied in early stages of group development, GCSS do not only increase task-oriented efforts but also personal and political ones, which is likely to decrease cooperation. On the other hand, when applied in latter stages of group development, GCSS do not affect the cooperation between members.

Finally, the studies that found a negative relationship between GCSS and confidence in the decision focused on groups in advanced stages of development, while the studies that found a positive relationship focused on groups in earlier stages of development. This suggests that GCSS decrease confidence when groups feel they can handle communication through already existing communication structures. In early stages, GCSS facilitate the focus of efforts on problems and seems to provide a support to the process that is needed. This explanation is supported by the negative relationship found in groups with high existing social networks (Gallupe et al., 1988; Watson et al., 1988; Zigurs et al., 1987), and a positive relationship found in groups with low social networks (Turoff and Hiltz, 1982).

6. The impacts of GDSS and GCSS: Comparison and contrast

Our review of empirical research suggests that GDSS and GCSS have similar impacts on some aspects of group processes and outcomes, but opposite impacts on other aspects. GDSS and GCSS both increase the depth of analysis of groups, increase participation, decrease domination by a few members, and increase decision quality.

On the other hand, GDSS increase consensus reaching, decrease decision time, increase task-oriented communication, increase confidence in the decision by the group members, increase the satisfaction of group members with the process, and increase the satisfaction of the group members with the decision. GCSS decrease cooperation, decrease task-oriented communication, increase the time to reach a decision, and decrease the confidence in decisions.

Our differentiation between GDSS and GCSS clarifies the findings of empirical research that otherwise seem inconsistent. When one analyzes the research without taking into account whether the electronic meeting system primarily supports communication or decision making, one finds very inconsistent results. There are evidences of increased and decreased confidence in decisions, task-oriented communication, and time to decide, and research seems inconclusive as to the effect of electronic meetings on consensus and the satisfaction of members with the group process. However, by grouping technological supports as either communication related (GCSS) or decision related (GDSS), the empirical evidences become consistent for each type of technological support. This suggests that GCSS and GDSS provide quite different support to groups and, consequently, have different impacts on them. The common impacts of GDSS and GCSS might be due to the similar support they provide to communication between group members. The differential impacts might be due to the fact that GDSS also support the decision process of groups.

Hence, it seems that GDSS and GCSS permit groups to channel the efforts of the members

toward task-oriented activities and therefore increase the depth of analysis and the decision quality. On the other hand, GDSS, by providing additional support to the group, increase the confidence members have in the decision, and increase their satisfaction with the decision and their satisfaction with the group process. GCSS, by also increasing personally oriented communication, decrease the cooperation between members and decrease the confidence of the group members in the decision.

There are three potential explanations for the differences in impacts discussed above. First, GCSS might not meet the expectations of the participants relative to their view of technologically supported group process. This might make them dissatisfied with the process and with the decision, and also decrease their confidence in the decision.

Second, our review shows that when GCSS are applied to groups in early stages of development (when there are no established communication network and pattern of participation yet), GCSS increase the confidence of group members in the decision. However, when GCSS are applied to groups at more advanced stages of development (when communication networks and pattern of participation are already established), GCSS do not seem to provide any perceived benefits, and consequently the confidence in the decision and the satisfaction with the group process decrease. GDSS on the other hand is perceived by the members as providing additional benefits at all stages of group development. This increases the confidence of the members in the decision, and their satisfaction with the decision and with the group processes.

It is important to note however that both GDSS and GCSS were found to increase the quality of the decision, and therefore the differential impact is only perceived. This difference in perception is nonetheless important because, if group members feel that GCSS are not efficient, or see them as harmful to group processes, the future of GCSS is threatened.

The third explanation for the difference in impacts is that GDSS focus group processes on the task and facilitate consensus. GCSS, also increase non-task related communication (e.g., political, personal). This might decrease consensus and cooperation and it might decrease the confidence of group members in the process. It might also decrease their satisfaction with the process and with the decision.

7. Implications for future research

This review of empirical findings on the impacts of technological supports on groups has significant implications for both of attention and the design of future research.

Four points concerning the focus of attention of future research stem from our review. First, most research effort is focused on a few factors of the formal dimension of group process, like decision quality, decision time, and depth of analysis. There is a lack of research on other important 'formal' factors of groups, such as how technological support affects communication and interpersonal processes of groups, and how technological support affects decision implementation and, consequently group-related outcomes.

Second, there is a paucity of research on the impacts of technological support on the 'informal' dimension of the group, like power struggles, status establishment, and hidden agendas. Yet, as argued by Schwartzman (1986) and other behavioral scholars, these informal aspects of groups might well be the most important dimension of meetings.

Third, the level of group development significantly affects how electronic meeeting systems affect group process, yet it is not taken into account in current research. This review shows the GDSS and GCSS have different impacts on groups, depending upon whether they are applied to groups that are early or advanced in their developmental process. More research is needed to better understand the impacts of the development factor on the success of GDSS and GCSS. Research in group psychology shows that important differences in group process can be expected between groups with and without meaningful history and future.

Fourth, the structure imposed on group processes by the technological supports seems to have important effects on groups, but has not been investigated. This review shows that findings on how GDSS and GCSS affect groups different whether the structure imposed by the technological support was controlled or not. This suggests that some impacts associated with the technologi-

cal supports are in fact due to greater structure in group processes. More research is needed to clarify the importance of this effect.

Three important points on the design of future research stems from our review. First, more studies were conducted in laboratory settings. Now that more electronic meeting systems become more widespread and that we have a basic understanding of how GDSS and GCSS affect groups, field studies in real organization settings are needed. Such field studies mean that researchers will have less control over contextual and independent variables than in laboratory settings. Therefore, they need to carefully identify and report the context in which the study was conducted. For this, Figure 1 and Tables 2 and 3 can be used as guidelines to the factors to be taken into account. The most important factors that stem from our review are: size of the group, type of the decision, complexity of the decision, group's development stage, reasons of members for joining the group, power and status relationships between group members, group's density, degree of anonymity, structure of group processes, and presence and quality of a facilitator.

Second, the research overall lacks a solid conceptual and theoretical grounding in reference disciplines such as group psychology, communication, and political science. Very few of the research teams are multidisciplinary, or employ multidisciplinary perspectives.

Third, there is too much of a 'black box' approach in the research, where the group process occurring in meetings is ignored. The focus is on manipulating independent variables, while controlling for the effect of the other variables, and observing change in the intervening and dependent variables without trying to understand or explain how and wy these changes occur. More studies focusing on understanding the group interaction process itself like that of Hiltz (1988) and Zigurs et al. (1988) are needed.

Appendix A. A framework for the analysis of the impacts of electronic meeting systems: Description of the variables

A.1. Contextual variables

Personal factors

Four personal factors have been found to affect group process in organization behavior. First is the attitude that group members have toward working in groups and working with the members of the group. Second is the ability of the members to work in a group. Third is the individual motives, or hidden agendas of group members, and fourth is the background of the group members which includes previous experience in working with groups and other factors like education or specific knowledge.

Situational factors

There are three main situational factors found to be important in previous research. First is the reasons for group membership, which can be categorized as voluntary reasons (social needs, self-esteem) or involuntary reasons (e.g. superior's request). Second is the existing social networks between group members, which have a direct impact on the communication and the interpersonal dimensions of group process. Third is the stage of development of the group (Tuckman, 1965): (1) testing and dependence, where group members attempt to understand acceptable and unacceptable behaviors and the norms of the group, (2) intragroup conflict, where members try to establish and solidify their position and also acquire influence over decisions made, (3) development of group cohesion, where members come to accept fellow members and the norms developed, and (4) functional performing, where the efforts of group members become mostly oriented toward task and goal accomplishment.

Group structure

Five aspects of group structure have been found to influence group process in organization behavior and group psychology research. These are: (1) work group norms, (2) power relationships, (3) status relationships between members (differentiation between the status of members), (4) group cohesiveness (sense of oneness, group spirit), and (5) density of the group, which is a composite factor made of the size of the group, the size of the room, and the interpersonal distance between group members.

Technological support

Technological support includes four basic subfactors. First is the type of support provided, whether it is a GCSS or GDSS. Second, is the

degree of support. This refers to how through its structure, capabilities, or technical characteristics the technological support facilitates the generation of alternatives, the choice of alternatives or the negotiation over alternative generation or choice. A third factor is the degree of anonymity the support permits, and a fourth factor is whether a facilitator is part of the support.

Task characteristics

Three main factors relating to task characteristics were found to be important in organization behavior and group psychology. First is the degree of complexity of the task. Second is the nature of the task (e.g., whether it is a financial task or a personnel task). Third is the degree of uncertainty associated with the particular task. For example, in decision making the uncertainty might relate to the consequences of the decision, or to information provided to make the decision, or both.

A.2. Group process variables

Decisional characteristics

Decisional characteristics includes the depth of analysis (number of alternatives generated, and number and complexity of the criteria used to evaluate these alternatives), the degree of participation of the group members, the degree of consensus reached in making a decision, and the time it takes to reach a decision.

Communication characteristics

Communication characteristics include the clarification efforts made by group members in trying to understand better the alternatives, the problem or the solution; the exchange of information between members (is there a tendency to withhold information?); non-verbal communication; and the degree of task-oriented communication between members.

Interpersonal characteristics

Interpersonal characteristics include the degree of cooperation in the group and the degree to which one or a few members dominate the group processes.

The degree of structure of the group processes

The structure of group processes has two dimensions. First is the degree of structure, or how standardized and stable are the decision, communication, and interpersonal processes. Second is the type of structure, or the extent to which the processes are hierarchically structured, and formal or informal.

A.3. Outcomes variables

Task-related outcomes

Task-related outcomes consist of two variables, each of which might be affected by technological support. The first variable is the characteristics of the decision. This includes the decision quality, the variability of the quality of the decision over time (or the consistency of group performance), and the breadth of the decision. The second task-related outcome is the attitude of the group members toward the decision. This includes the acceptance of the decision by the members, the comprehension of the decision, the satisfaction with the decision, and the confidence in the decision by the group members.

Group-related outcomes

Group-related outcomes include two main variables that might be affected by the technological support. First is the satisfaction of the group members with regard to the process. Second is the willingness of the group members to work in group the future, whether in this particular group, or in other groups.

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References

Benbasat, I., and Konsynski, B., eds. (1988), "Special section on GDSS", Special Issue of *Management Information Systems Quarterly* 12, 588–680.

Benbasat, I., and Nault, B.R. (1988), "An evaluation of empirical research in managerial support technologies: Decision support systems, group decision support systems, and expert systems", Report, Faculty of Commerce and Business Administration, University of British Columbia, Vancouver, BC.

Blanning, R., and King, D., eds. (1989), *Proceedings of the Twenty-Second Annual Hawaii International Conference on Systems Science*, IEEE Computer Society Press.

Bui, T., and Jarke, M. (1983), "A DSS for cooperative multiple criteria group decision making", in: L. Maggi, J.L. King and K.L. Kraemer (eds.), *Proceedings of the Fifth International Conference on Information Systems*, Tucson, AZ, 101–113.

Bui, T., and Sivasankaran, T.R. (1987), "GDSS use under conditions of group task complexity", Report, The US Naval Postgraduate School, Monterey, CA.

Bui, T., Sivasankaran, T.R., Fijol, Y., and Woodbury, M.A. (1987), "Identifying organizational opportunities for GDSS use: Some experimental evidence", *Decision Support Systems* 3, 68–75.

Dennis, A.R., George, J.F., Jessup, L.M., Nunamaker, J.F., Jr., and Vogel, D.R. (1988), "Information technology to support electronic meetings", *Management Information Systems Quarterly* 12, 591–619.

DeSanctis, G.L., and Gallupe, R.B. (1987), "A foundation for the study of group decision support systems", *Management Science* 33, 589–609.

Dickson, G.W., Lee, J.E., Robinson, L., and Heath, R. (1989), "Observations on GDSS interaction: Chauffeured, facilitated, and user-driven systems", in: R. Blanning and D. King (eds.), *Proceedings of the Twenty-Second Annual Hawaii International Conference on Systems Science*, IEEE Computer Society Press, 337–343.

Easton, A.C., Vogel, D.R., and Nunamaker, J.F. Jr. (1989), "Stakeholder identification and assumption surfacing in small groups: An experimental study", in: R. Blanning and D. King (eds.), *Proceedings of the Twenty-Second Annual Hawaii International Conference on Systems Science*, IEEE Computer Society Press, 344–352.

Ellis, C.A., Rein, G.L., and Jarvenpaa, S.L. (1989), "Nick experimentation: Some selected results", in: R. Blanning and D. King (eds.), *Proceedings of the Twenty-Second Annual Hawaii International Conference on Systems Science*, IEEE Computer Society Press, 370–377.

Galagher, J., Kraut, R.E., and Egido, C., eds. (1989), *Intellectual Teamwork: The Social and Technological Bases of Cooperative Work*, Lawrence Erlbaum, Hillsdale, NJ.

Gallupe, R.B., DeSanctis, G., and Dickson, G. (1988), "Computer-based support for group problem finding: An experimental investigation", *Management Information Systems Quarterly* 12, 277–296.

George, J.F., Easton, G.K., Nunamaker, J.F., and Northcraft, G.B. (1988), "A study of collaborative group work with and without computer-based support", Report, College of Business and Public Administration, University of Arizona, Tucson, AZ.

George, J.F., Northcraft, G.B., and Nunamaker, J.F. (1987), "Implications of group decision support system use for management: Report of a pilot study", College of Business and Public Administration, University of Arizona, Tucson, AZ.

Goffman, E. (1961), *Encounters*, Bobbs-Merrill, Indianapolis, IN.

Gray, P. (1983), "Initial observation from the decision room project", in: G.P. Huber (ed.), *DSS-83 Transactions, Third International Conference on Decision Support Systems*, June 27–29, Boston, MA, 135–138.

Hiltz, R.S. (1988), "Productivity enhancement from computer-mediated communication: A systems contingency approach", *Communications of the ACM* 31, 1438–1454.

Hiltz, R.S., Johnson, K., and Turoff, M. (1986), "Experiments in group decision making: Communication process and outcome in face-to-face versus computerized conferences", *Human Communication Research* 13, 225–252.

Hiltz, R.S., Turoff, M., and Johnson, K. (1988), "Experiments in group decision making, 3: Disinhibition, deindividuation, and group process in pen name and real name computer conferences", *Decision Support Systems* 5, 217–232.

Hymowits, C. (1988), "A survival guide to the office meeting: Executives face hidden agendas and late bosses", *The Wall Street Journal* June 21, 35–36.

Jarvenpaa, S.L., Rao, V.S., and Huber, G.P. (1988), "Computer support for meetings of groups working on unstructured problems: A field experiment", *Management Information Systems Quarterly* 12, 645–665.

Jelassi, M.T., and Beauclair, R.A. (1987), "An integrated framework for group decision support systems design", *Information and Management* 13, 143–153.

Jessup, L.M., Tansik, D.A., and Laase, T.D. (1988), "Group problem solving in an automated environment: The effects of anonymity and proximity on group process and outcome with a group decision support system", Unpublished manuscript.

Kraemer, K.L., and King, J. (1988), "Computer-based systems for cooperative work and group decision making", *Computing Surveys* 20, 115–146.

Leblanc, L.A., and Kozar, K.A. (1987), "The impact of group decision support system technology on vessel safety", Report, School of Management, Indiana University, Bloomington, IN.

Mintzberg, H. (1973), *The Nature of Managerial Work*, Harper & Row, New York, NY.

Mosvick, R.K., and Nelson, R.B. (1987), *We've Got to Start Meeting Like This*, Scott Foresman, New York, NY.

Neeley, N., and Woolbridge, R. (1987), "Touchstone: A text-oriented GDSS to elicit group thoughts", Report, Naval Postgraduate School, Monterey, CA.

Nunamaker, J.F., Jr. (1987), "Collaborative management work", *Management of Information Systems Conference*.

Nunamaker, J.F., Jr., ed. (1989), "Experience with and future challenges in GDSS (group decision support systems)", Preface to Special issue of *Decision Support Systems* 5, 115–118.

Nunamaker, J.F., Jr., Applegate, L.M., and Konsynski, B.R. (1987), "Facilitating group creativity: Experience with a group support system", *Journal of Management Information Systems* 3, 6–19.

Nunamaker, J.F., Jr., Applegate, L.M., and Konsynski, B.R. (1988), "Computer-aided deliberation: Model management and group decisions support", *Journal of Operations Research* 6, 826–848.

Nunamaker, J.F., Jr., Vogel, D., Heminger, A., Martz, B., Grohowski, R., and McGoff, C. (1989), "Experience at IBM with group support systems: A field study", *Decision Support Systems* 5, 183–196.

Pinsonneault, A., and Kraemer, K.L. (1989), "The impact of technological support on groups: An assessment of the empirical research", *Decision Support Systems* 5, 197–216.

Poole, M.S., Holmes, M., and DeSanctis, G. (1988), "Conflict

management and group decision support systems", *Proceedings of the Second Conference on Computer Supported Cooperative Work*, Portland, OR.

Schwartzman, H.B. (1986), "The meeting as a neglected social form in organizational studies", in: B.M. Staw and L.L. Cummings (eds.), *Research in Organizational Behavior*, JAI Press, Greenwich, CT, 233–258.

Siegel, J., Dubrovsky, V., Kiesler, S., and McGuire, T. (1986), "Group processes in computer-mediated communication", *Organizational Behavior and Human Decision Processes* 37, 157–187.

Smith, J., and Vanecek, M.T. (1989), "A nonsimultaneous computer conference as a component of group decision support systems", in: R. Blanning and D. King (eds.), *Proceedings of the Twenty-Second Annual Hawaii International Conference on Systems Science*, IEEE Computer Society Press, 370–377.

Steeb, R., and Johnson, S.C. (1981), "A computer-based interactive system for group decision-making", *IEEE Transactions* 11, 544–552.

Tuckman, B.W. (1965), "Development sequence in small groups", *Psychological Bulletin* 64, 384–399.

Turoff, M., and Hiltz, S.R. (1982), "Computer support for group versus individual decisions", *IEEE Transactions on Communications* COM-30, 82–90.

Vogel, D., and Nunamaker, J.F. (1988), "Group decision support impact: Multi-methodological exploration", in: J. Galegher, R.E. Kraut, and C. Egido (eds.), *Conference on Technology and Cooperative Work*, February 25–28, Tucson, AZ.

Vogel, D., Nunamaker, J.F., Applegate, L.M., and Konsynski, B.R. (1987), "Group decision support systems: Determinants of success", *DSS-87, Transaction, Seventh International Conference on Decision Support Systems*, 118–128.

Watson, R.T. (1988), "Group decision support systems (GDSS): Improving group decision making with information technology", *Proceedings of the IFIP TC-8 Conference: Information Technology Management for Productivity and Competitive Advantage*, Singapore, 2-56–2-71, March 7–8.

Watson, R.T., DeSanctis, G.L., and Poole, M.S. (1988), "Using a GDSS to facilitate group consensus: Some intended and unintended consequences", *Management Information Systems Quarterly* 12, 463–477.

Zachary, W. (1986), "A cognitively based functional taxonomy of decision support techniques", *Human–Computer Interaction* 2, 25–63.

Zigurs, I., DeSanctis, L., and Billingsley, J. (1989), "Exploring attitudinal development in computer-supported groups", in: R. Blanning and D. King (eds.), *Proceedings of the Twenty-Second Annual Hawaii International Conference on Systems Science*, IEEE Computer Society Press, 353–358.

Zigurs, I., Poole, M.S., and DeSanctis, G.L. (1987), "A study of influence in computer-mediated decision making", Report, MIS Department, Curtis L. Carlson School of Management, University of Minnesota, Minneapolis, MN.

Zigurs, I., Poole, M.S., and DeSanctis, G.L. (1988), "A study of influence in computer-mediated group decision making", *Management Information Systems Quarterly* 12, 625–644.